Exercise Sheet 1 due 23 October 2014

Course web site: `http://www.cond-mat.de/teaching/QM/`
Hand in exercises on due day before lecture to Hunter Sims

1. *Particle in a box*

An electron is in a potential well of 0.8 nm, with infinitely high potential barriers on either side. It is in the lowest possible energy state in this well. What is its energy? What would be the probability of finding the electron between 0.2 and 0.3 nm from one side of the well?

2. *Separation of variables*

Consider an electron in a three-dimensional square box of side lengths L with infinitely high potential walls.

i. Use separation of variables to find the eigenstates and eigenenergies of this three-dimensional box in terms of the eigenstates and eigenenergies of the one-dimensional particle in a box problem.

ii. Find an expression for the allowed energies of the electron in this box in terms of the lowest allowed energy, E_1^∞, of a particle in a one-dimensional box of width L.

iii. Explicitly write down the wavefunctions of the four lowest energy states. Different states of the same energy are called degenerate. Which of the states that you have calculated are degenerate?

3. *Python*

Use python (or iPython) to plot wavefunctions (see `http://matplotlib.org/`)

i. Plot the lowest two states for an electron in a one-dimensional box of width L =1 nm.

ii. Plot the lowest three states for an electron in a two-dimensional box of width L_x =1 nm in the x and L_y =2 nm in the y-direction.

For the adventurous: You can also use Google for your plot. Just type your wavefunction in the search-field. . .